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A Study of Tree Stocks in Relation to Winter Injury and Its Prevention

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Oregon State Agricultural College
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SUMMARY

1. Observations indicate that wide differences in character and extent of freezing injury differentiate certain apple and pear varieties from others. In field observations, Comice, Easter, and Flemish Beauty pears have been much less injured on the south side of the trunk than D'Anjou, Bosc, Bartlett, and the Winter Nelis variety. Newtown, Spitzenburg, Ortley, Jonathan, and Winter Banana suffered decidedly more than Astrachan, Arkansas, McIntosh, Ben Davis, and Delicious as a result of freezing damage on the southwest trunk exposure.

2. Varieties, susceptible to injury, where protected from the winter sun by windbreaks, timbered areas or buildings were found to be uninjured or only slightly injured in many locations.

3. On pear trees one to ten years of age, the use of white water paint and board shields has been found to lessen trunk damage materially.

4. Pear trees growing on Japanese rootstock have been found to be more subject to winter trunk damage than trees propagated on French seedling.

5. Seventy-eight apple varieties and forty-three pear sorts purporting to be winter hardy in varying degrees are under observation at the Hood River Station. These varieties are being used as intermediate stocks upon which local commercial varieties have been top-worked.

6. Winter-injury control is associated with perennial canker control. The susceptibility of the apple stocks to woolly aphis infestation —an important factor in canker infection—is being studied. Wide differences in susceptibility have been noted. Astrachan has been found to be highly resistant to woolly aphis. Although hardiness has not been completely demonstrated, the use of this variety in a limited way is suggested to growers.

7. The authors submit this as a progress report on their investigations relating to the use of intermediate stocks as a means of avoiding winter injury and perennial canker in the lower portions of the tree. Because of many unknown factors interrelated between stock and scion, not only from the standpoint of hardiness itself, but in tree responses, production, and general compatability, no definite recommendation can be made at this time.

A Study of Tree Stocks in Relation to Winter Injury and Its Prevention

By

Leroy Childs and Gordon G. Brown

Hood River Experiment Station

Character of winters. Low and widely fluctuating winter temperatures occurring in 1919, 1924, and 1926, caused serious injury to apple, pear, and other fruit trees in Pacific Northwest fruit districts, including the Hood River area. Greatest losses, as a rule, were due to the girdling effect of winter injury on tree trunks and basal portions of main branches. Reduced vitality, lessened fruit production, or, in extreme cases, death of trees resulted. This Circular briefly summarizes the main factors associated with such injury and the control measures under study.

Temperatures officially recorded at Hood River during the fall and early winter of 1919 were unusually and particularly severe. On October 25 a killing temperature of 17° F. occurred. Most fruit trees were in full foliage at that time. On December 11, -10° F. was recorded, with temperatures of -25°, -27°, -23°, and -9° on the following days. Resulting damage to fruit trees was more general and devastating than has ever been recorded before or since that time in mid-Columbia districts. In 1924 a sudden drop in temperature from 50° F. on December 15 to -6° on December 18 occurred, finally reaching -12° F. a week later—a range of 62° F. within a period of approximately ten days. There was no snow on the ground during this period. As a result of these weather conditions much damage of the sun-scald type developed.

During other years the following minimum temperatures prevailed with corresponding dates: December 14, 1926, -5° F.; February 8, 1929, -11° F.; and January 21, 1930, -19.5° F.

Field observations. Field observations indicated that wide differences in character and extent of freezing injury differentiated certain apple and pear varieties from others. A study of 5,290 bearing pear trees in 164 plantings demonstrated the fact that Comice, Easter, and Flemish Beauty were much less injured, particularly on the southwest side of the trunks, than D'Anjou, Bosc, Bartlett, and Winter Nelis. Ninety-three percent of the Comice trees showed no appreciable injury. Bartlett and D'Anjou were found to be very susceptible to trunk injury, especially the sun-scald type. Of the following apple varieties, none escaped injury: (a) Newtown, Spitzenburg, Ortley, Jonathan, and Winter Banana suffered greatest injury; (b) Astrachan, Arkansas, (Black Twig) McIntosh, Ben Davis, and Delicious, in order named, suffered least injury. Varieties showing greatest injury, as a rule, were found to be most susceptible to perennial canker infection. Orchards suffered most that were poorly located with reference

to air and soil drainage or had been subjected to mismanagement such as excessive irrigation, low soil fertility, and overcropping.

Observations made in many orchards following the 1919 and subsequent freezes have demonstrated the fact that the character of trunk ex-

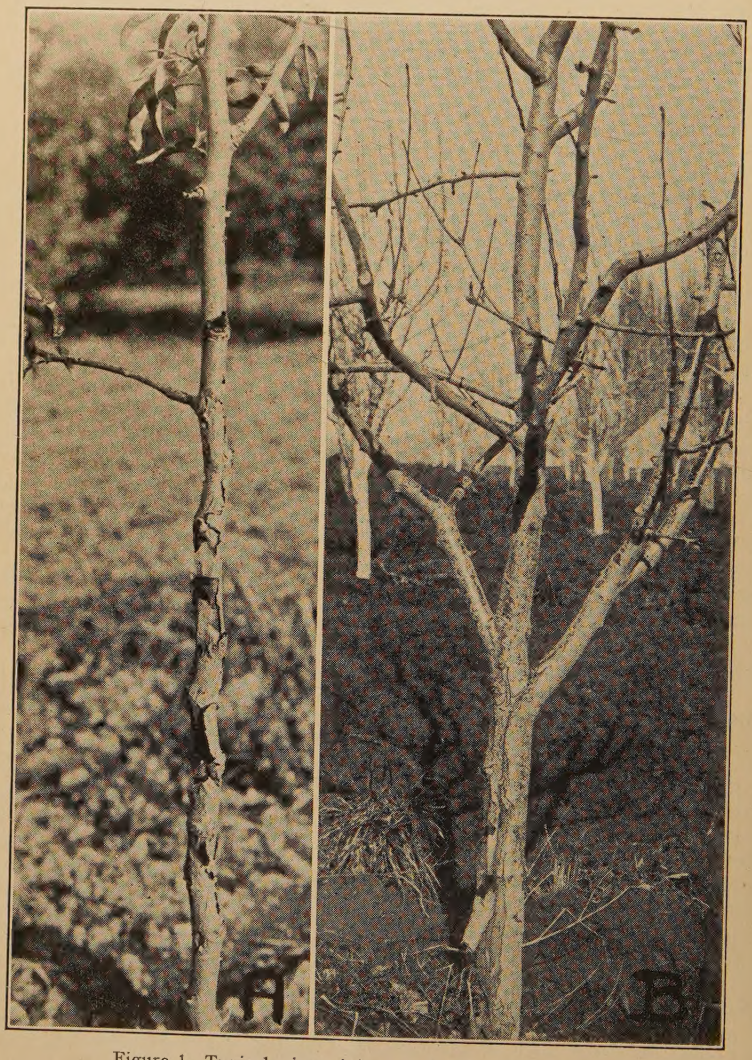

Figure 1. Typical winter injury on trunks of pear trees.

(A) One-year-old Anjou completely girdled.
(B) Sunscald on the southwest side of five-year-old Anjou pear trees. The use of tree paint as shown in Figure 2 has been found to reduce greatly this type of damage.

posure, particularly on the southwest side, to the direct rays of the sun has had much to do with the extent of damage that has occurred. Trees on pronounced north and northeastern slopes show much less damage at the present time than those otherwise located. It was further observed that trees protected from the direct rays of the sun by poplar windbreaks, timbered areas, or buildings, suffered slight or no injury, whereas adjacent unprotected trees suffered severe damage. Following the 1926 freeze Newtown apple trees in the Experiment Station orchard, protected from the

Figure 2. Home-made whitewashes, of which 'A' is representative, have failed to persist during the winter months. The paint application in 'B' is representative of several brands of cold-water paint prepared by several well-known paint manufacturers. Very effective control of trunk damage has been obtained when applications of the type shown in 'B' have been employed. Paint was applied in late November 1930; photograph taken February 23, 1931.

direct rays of the winter sun by timber and windbreaks, showed a trunk injury of varying degree in the amount of 18.18 percent. On the other hand, 75 percent of the unprotected trees suffered damage, most of which was severe in character. This condition was found to be typical of trees located in similar positions in many orchards. These observations indicated the possible value of trunk protection, an investigation of which was started in the fall of 1926.

The original tests were conducted in a ten-year-old D'Anjou orchard located on a pronounced western slope. Board troughs, made from 1" by 12" material, were placed about six inches from the trunk of these trees on the southwest exposure. The average length of the shields was about 3 feet. A sharpened stake was nailed to the side of one of the boards. This stake held the shield in place at the base. That portion of the stake extending above the trough was tied to a branch of the tree. This method proved satisfactory in holding the shield in position. The shields were placed in the orchard November 20, 1926. The condition of the trunks was determined in late summer, 1927. The following observations were made:

Treatment	Slight damage	Medium damage	Severe damage	Total damage
Board shields	3.3	.0	.0	3.3
No treatment	21.4	7.1	57.1	85.6

Further experiments bearing on the comparative merits of board shades, as above described, and whitewashing were begun in September, 1927. At that time the trunks and lower portions of limbs to a height of about three feet were whitewashed with the Lucas* brand of white water paint. The material was applied smoothly with a brush. Adhesive qualities were found to be excellent. A large proportion of the material originally applied remained on the surface during the following summer. Several home-made mixtures were tested. These failed to give satisfactory adhesiveness. No information relative to the effectiveness of whitewash or shields was obtained that year owing to the fact that a mild winter followed.

During the winter of 1928-29 additional data were collected. Severe freezing temperatures occurred in February. Normal maximum winter temperatures were followed by a temperature of -11° F. on February 8. Sub-zero temperatures prevailed for five days. Forty-seven percent of the days, during which time the minimum temperature was 15° or lower, were clear and with sunshine. Two tests were made involving the protection of six-year-old D'Anjou, Bartlett, and Bosc trees by means of board shields and white water paint.

Seventy-nine percent of unprotected trunks showed slight to severe injury following temperatures previously indicated. Behind the board shields 22 percent injury occurred, whereas but 6 percent damage was found on the painted trees.

This experiment was repeated in the winter of 1929-30. Low temperatures occurred in January. Fifty-two degrees F., the maximum temperature recorded, was followed by a minimum of -19.5° F. Zero or sub-zero

*Since 1928 other brands of white tree paint have been found satisfactory, including products of Fuller, Sherwin-Williams, and Hood River Spray Company.

temperatures occurred at different times over a period of more than two weeks, during which time many of the days were clear and bright. No crust formed on the snow, which varied in depth from two to fifteen inches. The practical value of white tree paint and the board shields in deflecting the sun's rays was clearly shown. The condition of the trunks of the pear

Figure 3. Type of board shield used in trunk-injury studies. This method has not been found as effective as the use of white paint. Low branches limit the use of shields on older trees, leaving the crotch area subject to injury.

trees used in this experiment was tabulated in the early summer of 1930. The percentage of trees showing damage, which varied from slight outer bark injury to complete girdling of the trunks, was as follows:

	Percent injury
Trees with no protection	40.0
Trees with board shields	19.2
Trees with white tree paint	10.0

Injury causing death to large areas was found only on the trunks of unprotected trees.

The data gathered over a period of four years have pointed out conclusively that the protection of trunks of young pear trees has materially reduced the amount and severity of winter sun-scald injury. White tree paint has proved more effective than board shields and is recommended, owing to the fact the paint can be applied to the crotch and lower portions of the main branches, an area which cannot be satisfactorily protected through the use of shields.

Trunk injury of pears on different rootstocks. Numerous orchard observations have been made since the occurrence of the 1919 freeze which have indicated that our pear sorts, chiefly D'Anjou, Bartlett, and Bosc, are more subject to severe trunk injury where growing on Japanese root-

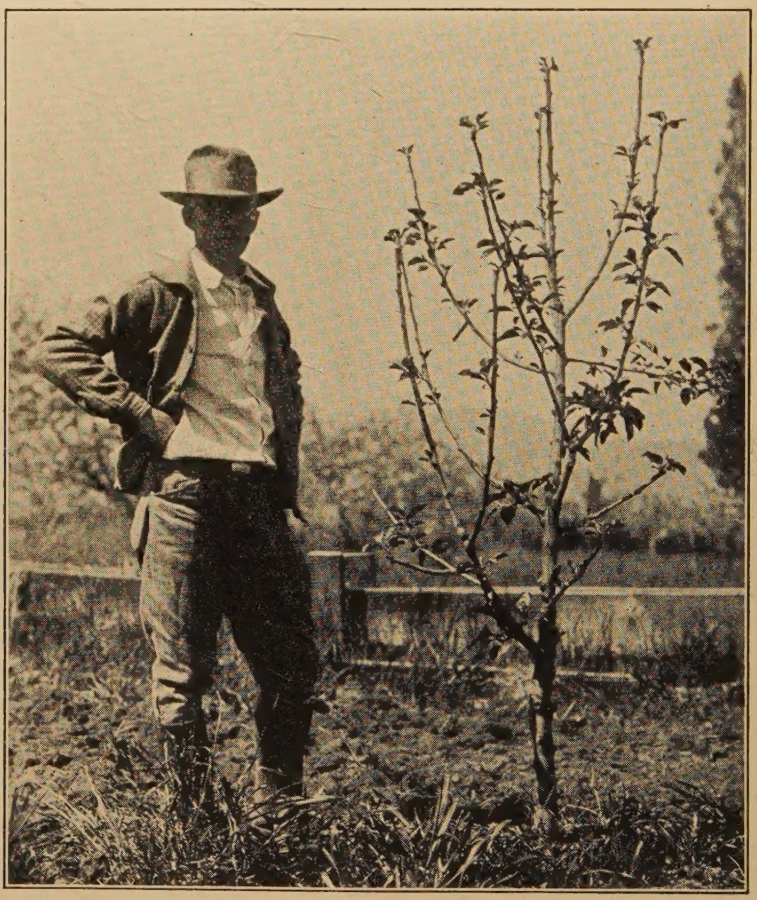

Figure 4. Although evidence is insufficient to recommend intermediate stocks generally as an aid in reducing winter damage, the practice is suggested where winter-injury conditions are critical. A trunk stock resistant to woolly aphis assures freedom from perennial canker in this area of the tree. Astrachan has been found highly resistant to the aphis and has indicated definite hardy characteristics in the Hood River area. This tree was budded in the second year after planting. Fourteen buds were employed, inserted at points where the tree had been cut back. A generous use of buds, well distributed, is most important in top-working of this character. (See Figure 5.)

stock, *Pyrus serotina,* than on French stock, *P. communis.* Since 1925 records have been kept in the Experiment Station orchard bearing upon this subject. During the period 1925 to 1930, pear trees growing on Japanese roots have shown a mortality—death and removal—of 14.6 percent; trees on French roots,

Figure 5. This is the same tree shown in Figure 4. Photograph taken at a similar distance from the tree three years after budding. A few of the budding points have been indicated. Our observations point out the fact that little or no checking of growth results from this character of top-working as compared to untreated trees.

3.1 percent. These observations are not strictly comparable owing to the fact that the trees on *serotina* are seven years of age, whereas the trees on *communis* are but five years old. Several varieties on both rootstocks were planted in the spring of 1928. Severe injury occurred the following winter. Without exception all varieties growing on *P. serotina* were much more seriously damaged than those growing on *communis*. The percentage of trees killed was as follows: trees on *serotina* 28.6 percent; trees on *communis* 6.1 percent.

Studies extending over a ten-year period demonstrate the fact that standard pear sorts grown in this district are more subject to winter trunk damage if propagated on Japanese root than on the French rootstock. This weakness, together with other disorders, such as black-end of the fruit, irregular ripening, and so-called cork-spot of the D'Anjou pear—all associated with the Japanese root—clearly point out the fact that the use of this stock is highly undesirable.

Shading and painting of apple trunks. Tests, involving the shading and painting of young apple trees have been under observation at the Station during the past three years. Up to the present time no information has been gathered, owing to the fact that no injury has occurred on unprotected and protected trees. Winter injury appears to be much more serious on young pear trees than on young apples (one to eight or ten years of age); on the other hand, sun-scald appears to be much more damaging in character on old apple trees than on old pear trees.

Intermediate stocks for topworking purposes. As a means of avoiding winter injury a study is being made at the Hood River Station to determine the possible value of employing hardier types of trees as trunk and framework for our desirable apple and pear sorts. Forty-three pear varieties and eighty-two apple varieties purporting to be winter hardy in varying degree have been topworked in the second and third year of their growth to the following varieties standard for this district: Newtown, Spitzenburg, Ortley, and Delicious, including the red strains. Pear sorts growing on different trunk and rootstocks are: D'Anjou, Bosc, and Bartlett.

Although many of these topworked trees are four and five years of age, data at hand are insufficient to warrant the drawing of any definite conclusions relative to the value of these stocks. A number of these varieties are crosses from parents of recognized hardiness developed at several horticultural institutions. We are indebted to the following State Experimental Stations for their assistance in supplying either trees or scion wood at various times: Minnesota; Southern Oregon; Iowa; Illinois; Michigan; Wisconsin; also the Dominion Experimental Farms, Horticultural Branch, Ottawa, Canada, and the Bureau of Plant Industry, United States Department of Agriculture.

The varieties and strains of apples and pears growing at the Hood River Station are:

APPLES

Alexander
Anisim
Antonovka
Arkansas (Black Twig)
Astrachan
Attison*

Bethel
Baxter
Ben Davis
Blushed Calville

Canada Baldwin
Charlamoff
Cortland

Delicious
Duchess
Dudley

Erickson

Fameuse
Folwell

Gold Medal
Goodhue
Gravenstein

Haas
Haralson
Herschel Cox*
Hibernal
Hyslop Crab

Jonathan

Liveland
Longfield

Malinda
Mann
McMahon
McIntosh*
McIntosh
Milwaukee
Minnehaha
Minnesota 447
Martha Crab
Missouri White Pippin

Newtown
Northwest Greening

Okabena
Ortley
Osman
Ostrakoff

Paradise Sweet*
Patten Greening
Peerless

Red Siberian
Red Wing
Richared

Salome
Scott Winter
Shields Crab
Sierra Beauty*
Spitzenburg:
Red Strains:
(a) Southern Oregon
(b) Goodenuf
St. Lawrence
Soulard
Starking
Success Crab
Sweet Orange*

Tetofsky
Tolman*
Tolman
Tolman x 821 *Malus floribunda*
Tolman x 852 *Malus toringo*
Tolman x 804-1 *Malus atrosanguinea*
Transcendent

Ukraine

Vermont*
Virginia Crab

Wallace Howard*
Wealthy
Whitney Crab
Winter Banana
Winter Rose

PEARS

Bali Hsiang No. 1
Bali Seedling No. 1
Bali Seedling No. 2
Bali Seedling No. 3
Bartlett
Bierschmitt

Bosc
Burkett

Chieh Li
Chien Pa
Comice

D'Anjou
Douglas

Easter
Estella

*Trees propagated by root cuttings originally selected from outstanding seedlings of the particular varieties received from Bureau of Plant Industry, January, 1927.

PEARS *(continued)*

Farmingdale	Keiffer	Patten
Flemish Beauty	Lemon	Serrulata
German Sugar	Lincoln	Sicamous No. 2
Guar Li Seedling No. 2	Longworth	Surprise
Hansen 38	Ma-Ti-Huang	Tait No. 1
Hardy	Mendal	Tait No. 2
Hung Guar Li Seedling No. 1	Minnesota No. 1	Vicar of Wakefield
Huang Hsiang Sui	Old Home	Variolosa
Hsiang Sui Li	Orel 15	Warner
Hung Guar Li		

Woolly aphis resistance desirable with hardy, intermediate stocks. In view of the fact that the woolly apple aphis and winter injury are associated with perennial canker infection of apple trees, these intermediate stocks are being studied for the purpose of determining their relative resistance to aphis attack. Wide differences in susceptibility to aphis occurrence have been observed in this group of apple trees. The development of an aphis resistant, intermediate stock, sufficiently hardy to withstand damage from winter temperatures is the aim of this work.

Owing to the fact that Arkansas (Black Twig) passed through several severe winters in the Hood River area with comparatively little trunk damage, the variety has been used rather extensively by growers during the past five or six years as an intermediate trunk stock. Our observations indicate, however, that the variety is not suitable. During the past six years a good many topworked trees have been killed as a result of winter injury. The variety is also very susceptible to woolly aphis attack which has permitted the development of perennial canker at points of budding or grafting. Buds placed in the trees in the fall have often been killed during the winter owing to the occurrence of aphis followed by canker infection. Astrachan appears to be much more suitable for topworking than Arkansas. It has been under observation during the past five years. The variety is highly resistant to woolly aphis, is a vigorous grower, and has thus far proved congenial with the apple varieties grown in this district upon which they have been topworked. Aphis observations, in the case of other varieties listed, are too limited to make a report at this time. Considered from the standpoint of vigor and favorable tree characteristics the following varieties appear to be leading the others as intermediate stocks: Virginia Crab, Haas, Hibernal, Canada Baldwin, Transcendent, and Northwest Greening.

Observations gathered to date indicate that the study of the value of intermediate stocks employed as a means of preventing winter trunk and crotch damage is one worthy of attention. Growers who employ intermediate stocks in the development of their orchards must recognize the fact that, relatively speaking, little knowledge is available to indicate what the ultimate outcome will be from such a practice. Time only can demonstrate the practicability of this endeavor. The influence of the intermediate stock on the topworked sort, its congeniality and other factors, such as

yields and quality of fruit, are yet to be determined. On the other hand, little is known relative to the influence of the less hardy tender top, on the ordinarily hardy intermediate stock. These and other problems offer themselves at this time. Because of these many unknown factors specific recommendations dealing with the use of intermediate stocks cannot be made at present.